

Monitoring and Controlling Your Project

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Software Process Improvement (SPI) Project

Purpose and Objectives

- **Purpose: To review approaches for software project monitoring and controlling**
- **Objective: Help you understand:**
 - **What to monitor**
 - **How to identify the need to apply controls**
 - **Ideas on corrective actions**

Why Do Monitoring and Control?

- You need to know what's happening on your project so you can avoid major cost, schedule, or quality problems
- NPR 7150.2 requires that you monitor (track) and control (take appropriate corrective action)
 - “The project shall ensure that actual results and performance are tracked against the software plans. [SWE-024]”
 - “The project shall ensure that corrective actions are taken and managed to closure when actual results and performance deviate from the software plans. [SWE-025]”
- NPR 7120.5 requires the Program Manager to “assure that projects are operating within the framework of the approved Program Plan”
 - Control is to “ensure that cost, schedule, safety, and performance commitments made at the program and project levels are demonstrable in terms of agreed-upon metrics”

Monitor the Project

- **So, what should you monitor ...**
 - **Cost (effort) and schedule performance**
 - **Requirements change**
 - **Quality of products and services**
 - **Status of your process activities**
 - **Stakeholder involvement**
 - **Data management**
 - **Risk status**

- **... and how do you monitor?***
 - **Measure actual performance parameters (cost, schedule, quality, status, etc.)**
 - **Compare actual to planned performance to identify variances**

Assess the Need for Control

- **For significant variances from plan ask:**
 - **Why do we have the difference between planned and actual values?** (*Look for the problem cause, not the symptoms.*)
 - **If the problem is not corrected, what will the impact be?**
- **If the impact is not acceptable, ask:**
 - **What do we need to do to control and correct the variance?**
 - **When can we be back on plan?**

Control the Software Project

- **What are you controlling?**
 - Variances between planned and actual performance
 - Impact of risks on the project
- **How do you control a variance?**
 - Implement a corrective action or risk mitigation
- **How do you select a corrective action?**
 - If possible, address the cause of the variance, not just the symptom
 - Look at internal approaches first; then look for help from outside

Approaches to Monitoring and Control

Monitoring Cost and Schedule

- **What you should monitor:**
 - Cost (\$\$ and effort) for the top 2 or 3 levels of your Work Breakdown Structure (WBS) and for your overall project
 - Schedule status
- **Sample ways to monitor:**
 - Compare actual staff metrics from WebTADs or contractors with plan
 - Compare actual completed events or activities with planned events or activities
 - Compare earned value (from point counting) to plan
- **Sample analysis questions:**
 - Why have fewer software development points been earned than planned?
 - How will this affect my delivery?

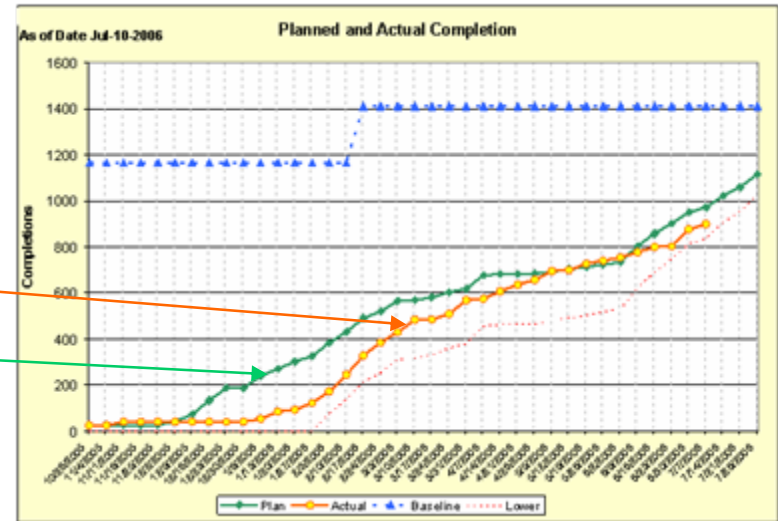
Controlling Cost and Schedule

- **Assess the need for corrective action:**
 - Look for the cause of a variance and determine how to reduce or eliminate it
 - Look at the symptoms and assess how to reduce or eliminate them
- **When to apply corrective action :**
 - Take corrective action when the answer to “How will this affect delivery?” is unacceptable
- **Example cost and schedule control approaches:**
 - Provide missing resources (e.g., hardware, software, tools, input information)
 - Create “Tiger Team” to resolve technical issues
 - Correct process problems
 - Train staff or correct skill mix
 - Focus resources on critical path

Monitor and Control: Schedule Example

■ Monitor schedule performance

- Use your regular schedule chart for event-based monitoring
- Use point counting to assess **earned** points against **planned** points
- Determine whether you are close to the planned rate of earning points



■ Control schedule performance

- Find out **WHY** variance is occurring – problem not symptoms
- Find out **WHAT IMPACT** the trend will have if it continues
- Determine what **CORRECTIVE ACTIONS** are needed to correct the problem
- Assess when you will **BE BACK ON PLAN**

■ Corrective actions can include:

- Added staff, different staff, change of staff mix
- Training of staff in process, tools, etc.
- Access to information, tools, equipment, etc., needed

Monitor and Control Your Cost and Schedule

- **Use Point Counting and Actual Hours to monitor cost**
 - Set up your point counting to earned points based on the resources (weeks, hours, etc.) you plan to spend on the activity
 - Check actual purchase costs against planned purchase costs
- **Look at your status relative to your plan**
 - Budget Monitoring – Are you spending money faster than planned?
 - Cost Monitoring – Is each hour resulting in more or less work done than planned?
 - Schedule Monitoring – Is work getting done as fast as planned?
- **Watch trends – take action to change unfavorable trends**
- **Remember to ask these questions:**
 - WHY is there a variance
 - WHAT IS THE IMPACT if nothing changes
 - WHAT CORRECTIVE ACTION needs to be applied
 - When will you be BACK ON PLAN

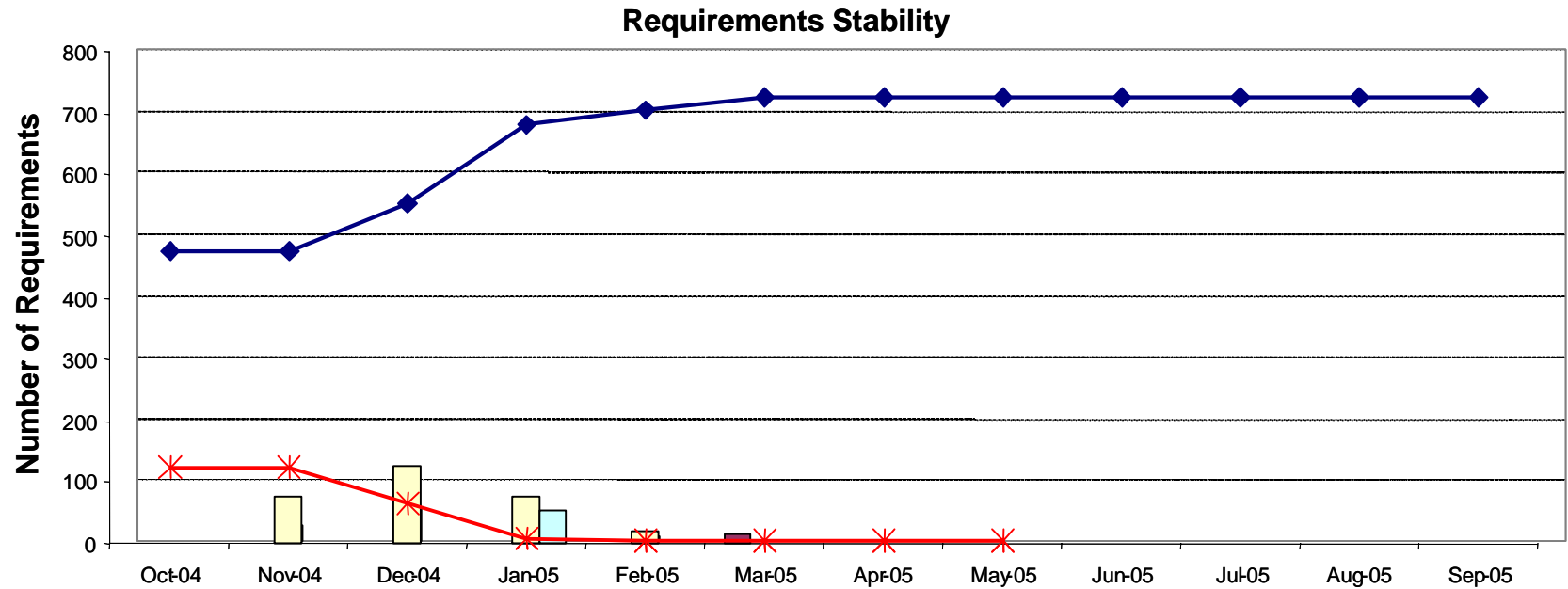
Monitoring Requirements

- **What you should monitor:**
 - Number of
 - Requirements in the baseline
 - To Be Determined (TBD) requirements
 - Requirement changes, additions, and deletions
- **Sample ways to monitor:**
 - Count the items (store results in an Excel spreadsheet)
- **Sample analysis questions:**
 - What do we need to resolve the TBDs?
 - Are we seeing more changes than planned ... and what's causing the changes?
 - How will this many requirement changes (requirement modification, addition, or deletion) affect the project?

Controlling Requirements

- **Assess the need for corrective action:**
 - If excessive numbers of changes occur, assess the adequacy of the baseline or requirements definition process
 - Look at requirement detail, requirement completeness, and the number of TBDs
- **When to apply corrective action :**
 - ALWAYS control requirement change; identify the impact of changes (or “holes” early)
 - Take action as early as possible to eliminate incomplete, unclear, or TBD requirements
- **Example requirement control approaches:**
 - Follow Configuration Management (CM) procedures for change request control
 - Eliminate TBDs as early as possible
 - Work with the stakeholders to help minimizes changes
 - Apply extra resources to requirements definition if the baseline is identified as incomplete

Monitor and Control: Requirements Example



	Oct 04	Nov 04	Dec 04	Jan 04	Feb 04	Mar 04	Apr 04	May 04	Jun 04	Jul 04	Aug 04	Sep 04
Changes	0	27	53	37	8	16	0	0				
Additions	0	78	127	78	22	0	0	0				
Deletions	0	0	0	53	0	0	0	0				
Baseline	475	475	553	680	705	727	727	727	727	727	727	727
TBDs	125	125	66	10	5	5	5	5				

Status: Requirements have begun to stabilize since the SRR in February but 5 TBDs remain.

Impact: One TBD could cause significant impact.

Corrective Action: We are working closely with the Project to resolve all remaining TBDs before the PDR in August. Status is reported weekly.

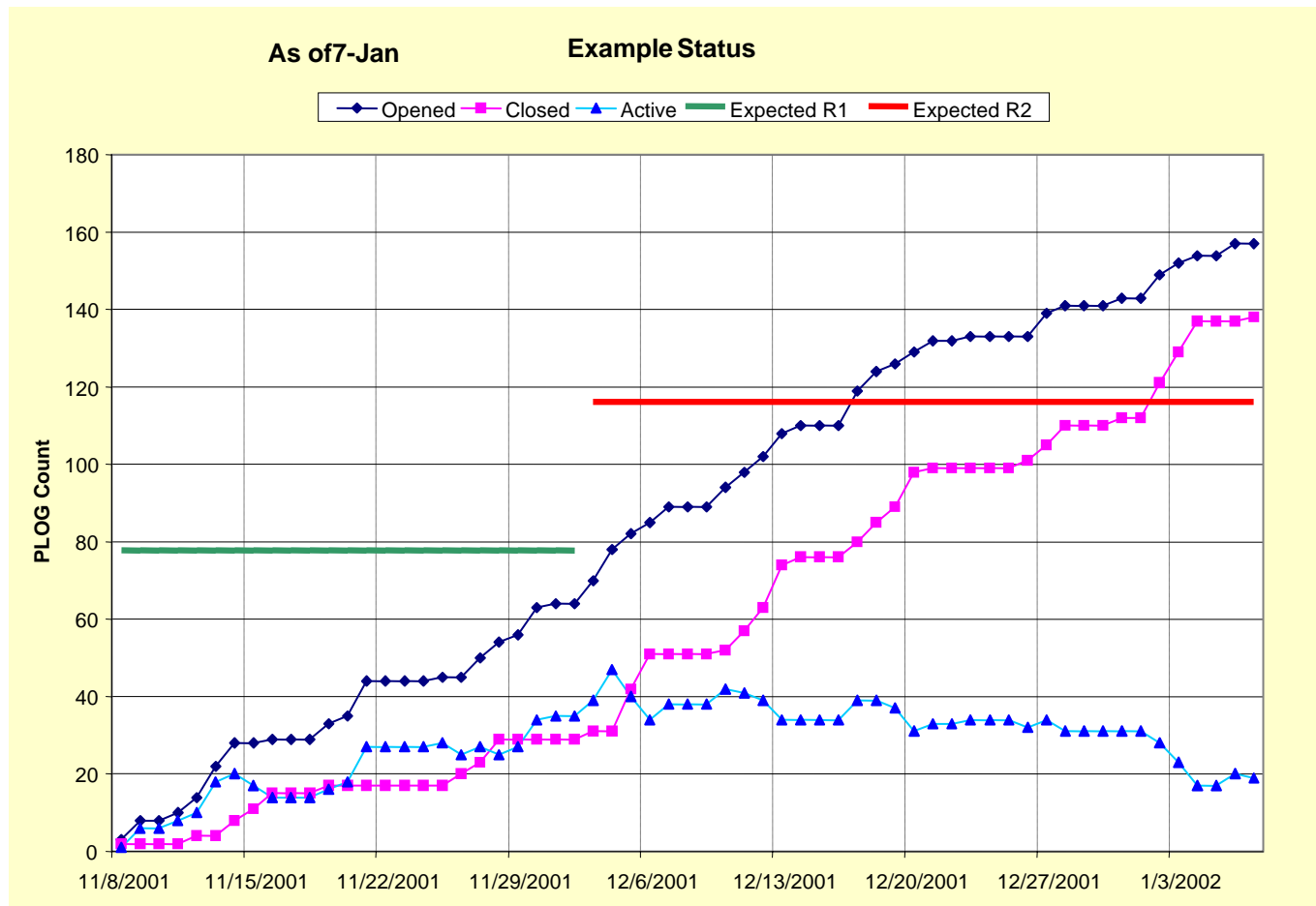
Monitoring Product and Service Quality

- **What you should monitor:**
 - Software requirements, design, and code quality
 - Documentation quality
 - Testing quality
- **Sample ways to monitor:**
 - Measure the level of requested requirements change
 - Count software defects
 - Count document Review Item Dispositions (RIDs), Discrepancy reports (DRs), or Change Requests
- **Sample analysis questions:**
 - Why are we seeing so many software change requests during development?
 - Why are there so many errors found during testing?
 - Why are so many documentation changes being proposed?

Controlling Product and Service Quality

- **Assess the need for corrective action:**
 - Measure performance, count defects, etc.
 - Use quality audits on key products and services
- **When to apply corrective action :**
 - Take corrective action when the product or service quality is not as planned or is likely to impact customer acceptance at any level
- **Sample product and service quality control approaches:**
 - Assess product quality as you go, not at the end
 - Ensure the staff knows all quality requirements
 - Train the staff in processes to be used
 - Tailor the process to specific project needs

Monitor and Control: Quality Example - Analyzing Defect Data



Status: More than expected number of reports, but opening and closing at about the same rate until near the end.

Impact: None since we are not gaining or losing ground.

Corrective Action: Additional attendees are now in the code walkthroughs and test inspections.

Monitoring Process Status

- **What you should monitor:**
 - Project planning activities
 - Project monitoring and control activities
 - Measurement and analysis activities
 - Configuration management activities
 - Product and process quality assurance activities
 - Requirements management activities
 - Supplier agreement management activities
- **Sample ways to monitor:**
 - Have the activities in your WBS and track associated activity and milestone schedules
 - Track the planned effort versus the actual effort required
- **Sample analysis questions:**
 - Are the activities being completed on schedule and if not, why?
 - Is the effort allocated adequate to do the job?

Example Process Activities to Monitor*

Project Planning

- WBS Defined
- Project costs estimated
- Project schedules established
- Project life cycle selected and documented
- Project risks identified
- Allocated resources to scheduled work

Supplier Agreement Management

- Acquisition type determined
- Suppliers selected
- Supplier agreements established / maintained
- Candidate COTS products reviewed
- Supplier agreement activities performed
- Acquired products accepted
- Acquired products transitioned to project

Measurement and Analysis

- Project measurement approach defined, planned, and documented
- Approval on measurement approach obtained
- Project measures defined
- Measurement data repository established
- Measures collected
- Measures analyzed and reported

Project Monitoring & Control

- Project progress collected and tracked
- Regular monitoring meeting held
- Milestone review prepared and presented
- Stakeholder involvement monitored
- Issues presented to management
- Risks monitoring and management performed
- Data management tracked
- Commitments obtained and tracked

Process & Product Quality Assurance

- Software assurance support with Code 300 negotiated
- Software Assurance Plan reviewed
- Conducted process audits
- Conducted product audits
- Non-compliance process / product issues recorded
- Non-compliance process / product issues resolved

Requirements Management

- Requisite commitments to requirements obtained
- Bi-directional traceability matrix developed / updated
- Requirement inconsistencies identified and resolved

Configuration Management

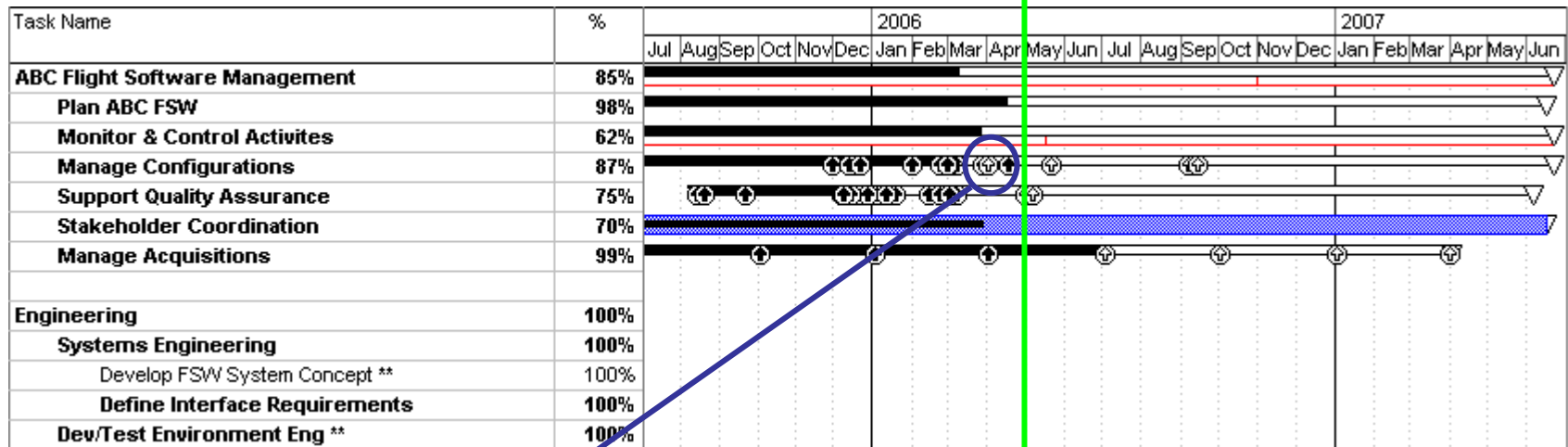
- CM approach defined, and documented
- Approval on CM approach obtained
- Configuration items identified / documented
- CM Audit conducted
- CCB meeting held
- Items placed under CM control
- Deliverable baseline established

****Monitoring process is required by CMMI. Tracking effort in each area would please CMMI Assessors. See CMMI for more examples of monitoring process.***

Controlling Process Status

- **Assess the need for corrective action:**
 - Plan process events for each area and monitor for adherence to schedule
 - Understand the process activity products and verify that they are produced as planned
- **When to apply corrective action :**
 - When process activities are not getting done or are late
 - When process artifacts are not produced and store in the project repository
- **Sample process status control approaches:**
 - Ensure that process activities are tracked in the WBS and schedule
 - Ensure that all staff understands and applies the required processes and produces the required artifacts
 - Ensure that adequate resources have been allocated to the activities
 - Control associated technical events (e.g., CM input products)

Monitor and Control: Process Status Example 1



Report Date

Missed milestones may mean
that corrective action is
needed

Monitor and Control: Process Status Example 2

Monthly Effort by Process Area					Actuals As Of: Jan-08	
Process Area	Planned Effort	Actual Effort	Variance	% Var.	Analysis	Corrective Plan
Management <i>Project Planning</i> <i>Project Monitoring and Control</i> <i>Measurement & Analysis</i> <i>Risk Management</i> <i>Acquisition Management</i>	0.30	0.38	-0.08	-27%	The effort required to complete the project plan exceeded planned effort as a result of extensive comments received. Plan is now complete.	No corrective action required
Configuration Management	0.02	0.02	0.00	0%	Actual met Planned	No corrective action required
Process and Product QA	0.00	0.00	0.00	0%	No PPQA planned this month	No corrective action required
Engineering <i>Systems Engineering</i> <i>Dev & Test Environment Eng</i> <i>Requirements Development</i> <i>Requirements Management</i>	0.01	0.00	0.01	100%	No engineering required this month	No corrective action required
Development	1.63	0.79	0.84	52%	Less effort was needed than planned to complete the software development activities.	No corrective action required
Verification and Validation	1.40	1.35	0.05	4%	While the staffing level was near the plan, additional staff is still needed to get the testing done on schedule	An additional tester will be made available half time for two months as a result of discussions with the Branch Head

Compare planned and actual effort ...

... then analyze the need for corrective actions

Monitoring Stakeholder Involvement

- **What you should monitor:**
 - Level of stakeholder involvement
 - Effectiveness of stakeholder involvement
- **Sample ways to monitor:**
 - Compare planned and actual meeting attendance
 - Count review comments or change requests received
 - Review approvals on signature pages
- **Sample analysis questions:**
 - Why is the Mission representative absent from the weekly meeting?
 - What kind of impact will this absence have on the software project?

Controlling Stakeholder Involvement

- **Assess the need for corrective action:**
 - Determine if communication with stakeholders is happening and effective
 - Compare the actual stakeholder coordination artifacts with the plan
- **When to apply corrective action :**
 - Take corrective action when stakeholder involvement is inadequate or threatens to compromise delivery cost, schedule, or quality
- **Sample stakeholder involvement control approaches:**
 - Talk to stakeholders to determine the problem cause
 - Modify approaches to improve coordination
 - Take stakeholder coordination into your hands with regular communication
 - Escalate real problem areas to management

Monitor and Control: Stakeholder Coordination Example

Date	Stakeholder Involvement Status
9/27/2007	Principal Investigator not showing up at the requirement meetings as planned; minutes emailed and request made for a backup. All other stakeholder involvement okay.
10/25/2007	Backup PI came to two meetings this month. All other stakeholder involvement okay.
11/29/2007	All stakeholder involvement okay.
12/29/2007	Point of contact for interface to external system ABC has left and no replacement identified. ICD development postponed until the new interface comes onboard.
1/25/2008	Replacement POC for ICD to ABC is attending meetings. All other stakeholder involvement okay.
2/27/2008	All stakeholder involvement okay.

Monitoring Data Management

- **What you should monitor:**
 - The items you've specified in your Data Management List (DML)
- **Sample ways to monitor:**
 - Compare the number of expected artifacts with the number stored on a regular basis
- **Sample analysis questions:**
 - Are the planned data records being collected and stored per the prescribed frequency?
 - Are the records in the identified locations?
 - Why are there fewer purchase requests than expected?

Controlling Data Management

- **Assess the need for corrective action:**
 - Periodically check the artifacts captured against those expected
 - Check that artifacts are in the proper repository location
- **When to apply controls:**
 - Take corrective action when artifacts are not being captured as planned
- **Sample data management control approaches:**
 - Ensure all Team members understand what artifacts are needed and where they should be stored
 - Work with any Team member who consistently forgets to capture artifacts

Monitor and Control: Data Management Example

Monitoring Expected Data Management Artifacts

Data Management List (DML)		FY 2008				FY 2009			
Title	Description / Notes	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Data Management List (DML) (this list)	This is important to Planning, Monitoring and Control and CM	✓							
CM/DM Plan	See SMP/PP section 6.0		✓						
Project Plan			✓						
Acquisition Management Plan	See SMP/PP section 4.0		✓						
Schedule	Schedule, notes and inputs to schedule in the form of redlines/emails	✓		✓					

Monitoring Risk Status

- **What you should monitor:**
 - Each open risk
 - Items identified as potential risks, but not on risk list
- **How to monitor/analyze:**
 - Determine if risk can be retired
 - Determine if risk is likely to happen
 - Re-assess risk probability (likelihood), potential impact (consequences), and exposure
- **Sample analysis:**
 - Look at Status: Trying to get network expert needed in January and it's currently November
 - Classify Risk: Likelihood of risk is now rated very high and impact is rated high

Controlling and Mitigating Risk

- **Assess the need for corrective action:**
 - Check the risk triggers for each risk
 - Check the last exposure assessment after updating all risk parameters
- **When to apply controls (mitigation approaches):**
 - When a risk trigger date is nearing, a trigger event is about to occur, or a trigger event has occurred
 - Apply the mitigation if the exposure level is less than or equal to the cost of mitigation
- **Sample risk mitigation and control approaches:**
 - Adjustments in schedule, staffing, staff training, resource allocation, priority, communication and coordination, etc.

Monitor and Control: Risk Example

Project: ABC

Report Date: 02/01/07

Trend	Probability	Impact				
		VL	L	M	H	VH
	VH	0	0	0	0	0
	H	0	0	0	0	1
	M	1	0	0	1	0
	L	0	0	1	0	0
	VL	0	0	0	0	0

I = Improving
W = Worsening
U = Unchanged
N = New

Exposure	New	Modified	Retired	Open
R	0	0	0	1
Y	0	0	0	1
G	2	0	0	2
Totals	2	0	0	4

Risk ID	Rank	Trend	Risk Title	Assigned To	Exposure	Timeframe	State	Identified	Reviewed
1	1	U	My First Risk 1	Donna	Y	1-3 mo	Watch	01/01/07	01/25/07
2	1	N	My Second Risk	Bob	G	1-3 mo	Watch	01/02/07	01/10/07
3	1	W	My Third Risk	Mark	R	<1 mo	Mitigate	01/03/07	01/20/07
4	1	N	Risk 4	Dave	G	> 3 mo	Research	01/04/07	<Date>

Summary

Detail

Risk ID:	1	My First Risk 1	State:	Watch
Identified:	01/01/07	Y	Rank:	1
Originator:	Page	(Exposure (calculated)) ▲	Source:	Tech
Assigned To:	Donna		Category:	Mgmt
Probability:	Medium		Visibility:	Internal
Impact:	High	Trend ▼	Reviewed:	01/25/07
Timeframe:	1-3 mo	Unchanged	Modified:	<Date>
Condition:	Because of the complexity of the varied instrument interfaces to be accommodated			
Consequence:	The team could miss some specific interface details, causing problems during interface testing.			
Context:	The mission includes three instruments and one tech demo experiment. Because each instrument has heritage, there are seven unique interface protocols to deal with in the xyz software. While each protocol is fairly simple by itself, considered all together, the combination is very complicated.			
Status:	<p>July 2006 - All ICDs were approved.</p> <p>June 2006 - The Instrument Manager code is being prototyped in Build 2. Interface tests with instrument breadboards/ETUs will begin in September.</p>			
Assigned To	Step Number	Mitigation Step Description / Status	Planned	Actual
<name>	1	Description of Step 1	<date>	<date>
<name>	2	Description of Step 2	<date>	<date>
<name>	3	Description of Step 3	<date>	<date>
<name>	4	Description of Step 4	<date>	<date>

Keeping Records

Products of the monitoring and control process that should be kept in the project data stores:

- **Measures, metrics, or monitoring data collected on a regular basis (weekly, monthly, etc.)**
- **Analysis information (like the spreadsheets that provide variance analysis)**
- **Corrective actions applied (can be in the form of a note or email, the regular status report, etc.)**
- **Any operating plans associated with the corrective actions applied**
- **Lessons learned (about estimate validity, corrective action success, risks to watch for, etc.)**

Pitfalls to Avoid

- Not monitoring status of all aspects of the project
- Not having enough interim milestones or measurement points to objectively monitor status
- Not monitoring status frequently enough
- Not looking at trends
- Not addressing the cause of a variance, but addressing the symptom
- Not considering potential impacts of corrective actions – for example, actions taken to address schedule variances will generally affect cost
- Not monitoring the effects of corrective actions applied

Summary

- Remember to monitor both technical (product) and process activities
- Include the measurement and monitoring activities required in your project plan
- Monitor by comparing what's actually happening to your plan and watch the performance trends
- Assess any significant variances or unfavorable trends
 - WHY is there a variance
 - WHAT IS THE IMPACT if nothing changes
 - WHAT CORRECTIVE ACTION needs to be applied
 - When will you be BACK ON PLAN
- Control by applying corrective actions aimed at fixing the CAUSE of the variance as well as the variance itself
- Watch the impact of your corrective actions by closely monitoring changes in performance trends
- Keep your records ... they can help you on the next project

Questions?

Acronyms

- **CM – Configuration Management**
- **CMMI – Capability Maturity Model Integrated**
- **DML – Data Management List**
- **DR – Discrepancy Report**
- **NPR – NASA Procedural Requirement**
- **PDR – Preliminary Design Review**
- **PPQA - Process and Product Quality Assurance**
- **QA – Quality Assurance**
- **RID – Review Item Disposition**
- **SPI – Software Process Improvement**
- **SRR – System Requirements Review**
- **TBD – To Be Determined**
- **WBS – Work Breakdown Structure**
- **YTD – Year to Date**